N_2O emission from a maize cropping system influenced by replacing fallow with cover crops and its subsequent incorporation into the soil.

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1. Background & Objectives

Application of nitrogen (N) fertilizers in agricultural soils increases the risk of N loss to the atmosphere in the form of ammonia (NH_3), nitrous oxide (N_2O) and nitric oxide (NO) and the water bodies as nitrate (NO_3^-). The implementation of agricultural management practices can affect these losses. In Mediterranean irrigation systems, the greatest losses of NO_3^- through leaching occur within the irrigation and the intercrop period. One way to abate these losses during the intercrop period is the use of cover crops that absorb part of the residual N from the root zone (Gabriel and Quemada, 2011). Moreover, during the following crop, these species could be applied as amendments to the soil, providing both C and N to the soil. This effect of cover and catch crops on decreasing the pool of N potentially lost has focused primarily on NO_3^- leaching. The aim of this work was to evaluate the effect of cover crops on N_2O emission during the intercrop period in a maize system and its subsequent incorporation into the soil in the following maize crop.

2. Materials & Methods

Fifteen plots were set in the field and five cover cropping treatments, barley (*Hordeum vulgare* L.), vetch (*Vicia villosa* L.), rape *(Brassica napus* L.*)*, bare fallow and bare fallow without previously N fertilization as a control soil, were arranged in a fully randomized design with three replicates. Cover crops were broadcast in October 2009 and treated with glyphosate in March 2010. The cover crop residue was incorporated by ploughing to the soil in half of each plot and removed in the other half. Maize was sowed in April 2011 and harvested in September 2010. Irrigation during the maize crop was applied according to crop evapotranspiration. Each plot received 120 kg ha^{-1} of P and K (before sowing maize) and 150 kg N ha^{-1} as NH_4NO_3 split in two applications (2/3 at the end of May and 1/3 at the end of June) except in the bare fallow soil without N application. N_2O emissions were sampled using the chamber technique (Roelle et al., 1999) and analyzed by gas chromatography using a HP-6890 gas chromatograph equipped with a Plot-Q capillary column and a ^{63}Ni micro electron-capture detector (μECD).

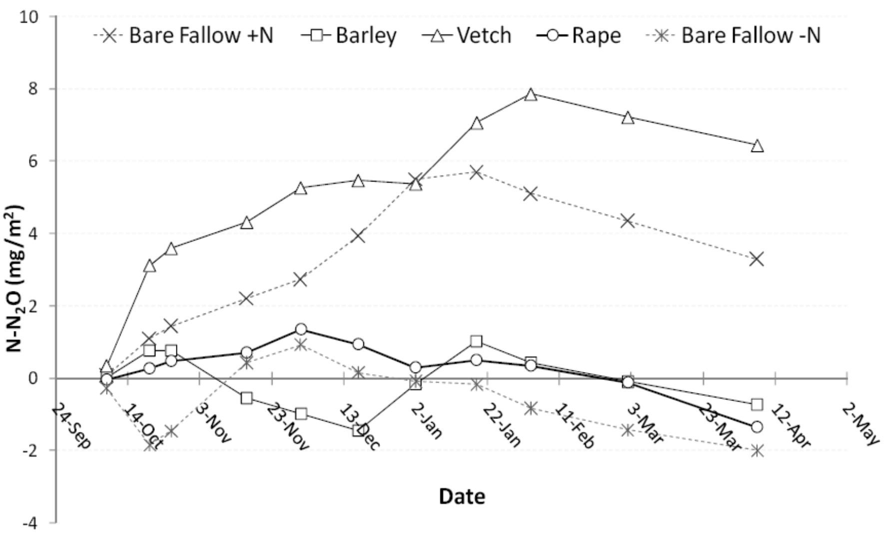

Figure 1. Cumulative N_2O fluxes from soils in the intercropping period.

3. Results & Discussion

In the intercrop period, N_2O emissions from soil were influenced by the presence of cover crops (Figure 1). The presence of barley and rape decreased N_2O emission but not significantly (P>0.05).

In contrast, emissions from the vetch increased (*P*=0.001) in the same period. That different cover crop behaviour could be due to the fact that vetch is a legume that fixes atmospheric N_2 resulting in a lower uptake of residual N and soil mineral N accumulation (Gabriel and Quemada, 2011).

During the maize crop, N_2O emission was influenced by the application of N fertilizer and the incorporation of cover crop residues (Figure 2). N_2O emissions were higher (P>0.05) in the N fertilized soils and also increased once that the barley and rape straws were incorporated into the soil in comparison with the no-residue incorporation. However, the opposite effect occurred when vetch residues were used as green manure. Mineralization of plant residues and thus the N_2O emission was found to be dependent on the C:N ratio of the residues (Eichner, 1990) and the amount of C in the incorporated biomass. Lower C:N ratio of the residues induce higher concentration of DOC and larger amount of N_2O emission (Huang et al., 2004). Barley and rape residue incorporation might stimulate microbial growth and activity and thus resulting in a higher denitrification capacity.

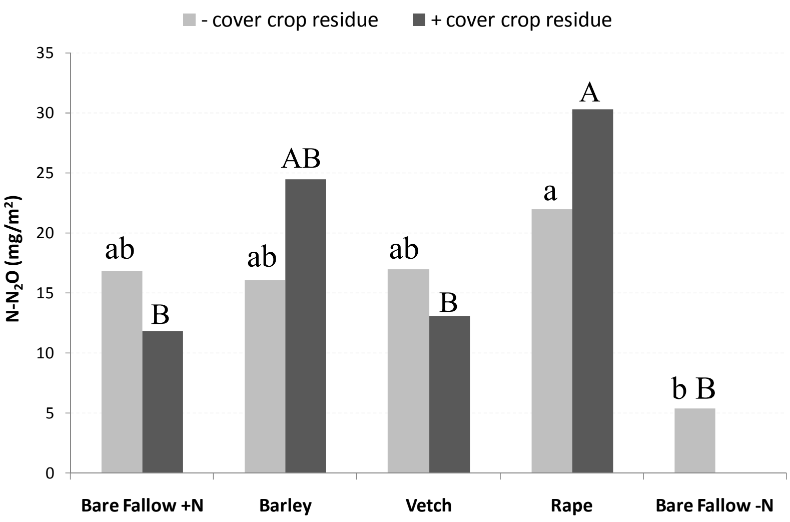

Figure 2. Cumulative N_2O fluxes from soils in the maize crop without and with cover crop residue incorporation.

4. Conclusion

This study underlines the role of the use of barley and rape cover crops in intercropping periods as a N_2O abatement strategy. In contrast, the incorporation of barley and rape residues increased these emissions. Based on these results, its addition cannot be regarded as a good mitigation strategy under the conditions of the experiment.

References

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